(*Canis vulgaris*) from Savoy, presented by M. Leon Montaigne; a White-crested Tiger-Bittern (*Tigriosoma leucolophum*) from West Africa, presented by Mrs. F. M. Hand; nine Pheasant-tailed Jacanas (*Hydrophasianus chirurgus*) from India, presented by Mr. Frank Finn; a Horned Capuchin (*Cebus apella*) from South America, a Feline Douroucouli (*Nyctipithecus vociferans*) from South Brazil, four Crowned Partridges (*Rollulus cristatus*) from Malacca, deposited; a White-tailed Gnu (*Connochaetus gnu*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

DIAMETER OF JUPITER.—In continuation of his series of determinations of planetary diameters with the 26-inch refractor at Washington, Prof. T. J. J. See gives the reduced measures of Jupiter in *Astronomische Nachrichten*, Bd. 157, No. 3757. The observations were made during daylight, using the colour screen over the eye-piece for eliminating the secondary fringes, &c. For the final evaluation of the diameter sixty-eight measures are employed, extending over the period 1901 September 6-October 1; from these he gives:—

$$\text{Equatorial diameter of Jupiter} = 37''\cdot646 \pm 0''\cdot014$$
$$= 141{,}950 \pm 53 \text{ km.}$$

Prof. See thinks this very closely approximates to the absolute value of the diameter, and by comparing it with the value obtained at night, when the planet is seen as a very brilliant object on a dark background, he obtains a measure of the irradiation. The night value is $38''\cdot40$, which gives for the irradiation:—

$$I = 0''\cdot755 \pm 0''\cdot040$$
$$= 2847 \pm 150 \text{ km.}$$

As these values are so different, the suggestion is made of the advisability of adopting two sets of planetary diameters, one representing the apparent size of the planet as seen at night, to be used in physical observations and ephemerides, work on satellites, &c., the other representing the true dimensions of the spheroid independent of its illumination by the sun, to be employed in the theory of the planet's figure, constitution, &c.

The resulting absolute dimensions of the Jovian spheroid referred to the distance 5·20 are:—

Equatorial diameter	= $37''\cdot646$	= 141,950 km.
Polar diameter ...	= 35·222	= 132,810 km.
Oblateness	= 1:15·53.	
Assumed mass ...	= 1:1047·35 (Newcomb).	
Density	= 1·35 (water = 1).	

"THE HEAVENS AT A GLANCE," 1902.—This handy little publication for the present year is issued in a slightly modified form. The author has repeatedly had inquiries respecting the inclusion of one or more star maps, and the present edition is furnished with two, one showing the northern stars, the other the southern objects visible from Great Britain. Another additional feature is the small map of the moon, showing the principal lunar formations.

All the more important phenomena are given for the year, and a series of summaries of the particulars relating to variable and coloured stars, nebulæ, &c.

VARIABLE STAR CATALOGUE.—In the *Astronomical Journal*, vol. xxii. No. 514, the committee appointed by the Council of the Astronomische Gesellschaft publish a further catalogue giving the elements of stars which have been certainly recognised as variable since the publication of Chandler's third catalogue (*Astronomical Journal*, vol. xvi., pp. 145–172). The present list gives the definitive designations for 191 variables, and also for the three Novæ in Perseus, Sagittarius and Aquila.

CATALOGUE OF 100 NEW DOUBLE STARS.—*Bulletin* No. 12 from the Lick Observatory comprises the fourth catalogue of new double stars having distances under 5″, discovered by W. J. Hussey with the 36-inch telescope at Mount Hamilton. (The first three catalogues appeared in the *Astronomical Journal*, Nos. 480, 485, 494.)

The search is being conducted in a systematic manner, and it is hoped that the work when more advanced will afford data for an investigation into the distribution of close double stars in various parts of the sky, and of their numbers with respect to magnitude.

THE TEACHING OF MATHEMATICS IN PUBLIC SCHOOLS.

THE following letter has been sent to the Committee appointed by the British Association to report upon the teaching of elementary mathematics.

GENTLEMEN,—At the invitation of one of your own body, we venture to address to you some remarks on the problems with which you are dealing, from the point of view of teachers in public schools.

As regards geometry, we are of opinion that the most practical direction for reform is towards a wide extension of accurate drawing and measuring in the geometry lesson. This work is found to be easy and to interest boys; while many teachers believe that it leads to a logical habit of mind more gently and naturally than does the sudden introduction of a rigid deductive system.

It is clear that room must be found for this work by some unloading elsewhere. It may be felt convenient to retain Euclid; but perhaps the amount to be memorised might be curtailed by omitting all propositions except such as may serve for landmarks. We can well dispense with many propositions in the first book. The second book, or whatever part of it we may think essential, should be postponed till it is needed for III, 35. The third book is easy and interesting; but Euclid proves several propositions whose truth is obvious to all but the most stupid and the most intellectual. These propositions should be passed over. The fourth book is a collection of pleasant problems for geometrical drawing; and, in many cases, the proofs are tedious and uninstructive. No one teaches Book V. A serious question to be settled is—how are we to introduce proportion? Euclid's treatment is perhaps perfect. But it is clear that a simple arithmetical or algebraical explanation covers everything but the case of incommensurables. Now this case of incommensurables, though in truth the general case, is tacitly passed over in every other field of elementary work. Much of the theory of similar figures is clear to intuition. The subject provides a multitude of easy exercises in arithmetic and geometrical drawing; we run the risk of making it difficult of access by guarding the approaches with this formidable theory of proportion. We wish to suggest that Euclid's theory of proportion is properly part of higher mathematics, and that it shall not in future form part of a course of elementary geometry. To sum up our position with regard to the teaching of geometry, we are of opinion—

(1) That the subject should be made arithmetical and practical by the constant use of instruments for drawing and measuring.

(2) That a substantial course of such experimental work should precede any attack upon Euclid's text.

(3) That a considerable number of Euclid's propositions should be omitted; and in particular

(4) That the second book ought to be treated slightly, and postponed till III, 35, is reached.

(5) That Euclid's treatment of proportion is unsuitable for elementary work.

Arithmetic might well be simplified by the abolition of a good many rules which are given in text-books. Elaborate exercises in vulgar fractions are dull and of doubtful utility; the same amount of time given to the use of decimals would be better spent. The contracted methods of multiplying and dividing with decimals are probably taught in most schools; when these rules are understood, there is little left to do but to apply them. Four-figure logarithms should be explained and used as soon as possible; a surprising amount of practice is needed before the pupil uses tables with confidence.

It is generally admitted that we have a duty to perform towards the metric system; this is best discharged by providing all boys with a centimetre scale and giving them exercise in verifying geometrical propositions by measurement. Perhaps we may look forward to a time when an elementary mathematical course will include at least a term's work of such easy experiments in weighing and measuring as are now carried on in many schools under the name of physics.

Probably it is right to teach square root as an arithmetical rule. It is unsatisfactory to deal with surds unless they can be evaluated, and the process of working out a square root to five places provides a telling introduction to a discourse on incommensurables; furthermore, it is very convenient to be able to assume a knowledge of square root in teaching graphs. The

same rule is needed in dealing with mean proportionals in geometry.

Cube root is harder and should be postponed until it can be studied as a particular case of Horner's method of solving equations approximately.

Passing to algebra, we find that a teacher's chief difficulty is the tendency of his pupils to use their symbols in a mechanical and unintelligent way. A boy may be able to solve equations with great readiness without having even a remote idea of the connection between the number he obtains and the equation he started from. And throughout his work he is inclined to regard algebra as a very arbitrary affair, involving the application of a number of fanciful rules to the letters of the alphabet.

If this diagnosis is accepted, we shall be led naturally to certain conclusions. It will follow that elementary work in algebra should be made to a great extent arithmetical. The pupil should be brought back continually to numerical illustrations of his wcrk. The evaluations of complicated expressions in a, b and c may of course become wearisome; a better way of giving this very necessary practice is by the tracing of easy graphs. Such an exercise as plotting the graph $y = 2x - \frac{x^2}{4}$ provides a series of useful arithmetical examples, which have the advantage of being connected together in an interesting way. Subsequently, curve-tracing gives a valuable interpretation of the solutions of equations. Experience shows that this work is found to be easy and attractive.

With the desire of concentrating the attention of the pupil on the meaning rather than the form of his algebraical work, we shall be led to postpone certain branches of the subject to a somewhat later stage than is usual at present. Long division, the rule for H.C.F., literal equations and the like will be studied at a period when the meaning of algebra has been sufficiently inculcated by arithmetical work. Then, and not till then, will be the time to attend to questions of algebraic form.

But at no early stage can we afford to forget the danger of relapse into mechanical work. For this reason it is much to be wished that examining bodies would agree to lay less stress upon facility of manipulation in algebra. Such facility can generally be attained by practice, but probably at the price of diminished interest and injurious economy of thought. The educational value of the subject is sacrificed to the perfecting of an instrument which in most cases is not destined for use.

To come to particulars, we think that undue weight is often given to such subjects as algebraic fractions and factors. The only types of factors which crop up continually are those of $x^2 - a^2$, $x^2 \pm 2ax + a^2$, and, generally, the quadratic function of x with numerical coefficients.

In most elementary algebra books there is a chapter on theory of quadratic equations in which a good deal of attention is paid to symmetric functions of roots of quadratics. No further use is to be made of this until the analytical theory of conics is being studied. Might not the theory of quadratics be deferred until it can be dealt with in connection with that of equations of higher degree?

Indices may be treated very slightly. The interpretation of negative and fractional indices must of course precede any attempt to introduce logarithms; but when the extension of meaning is grasped, it is not necessary to spend much more time on the subject of indices; we may push on at once to the use of tables.

It will be seen that our recommendations under the head of algebra are corollaries of two or three simple guiding thoughts, the object in view being—to discourage mechanical work; the means suggested—to postpone the more abstract and formal topics and, broadly speaking, to arithmeticise the whole subject.

The omission of part of what is commonly taught will enable the pupil to study, concurrently with Euclid VI., a certain type of diluted trigonometry which is found to be within the power of every sensible boy. He will be told what is the meaning of sine, cosine, and tangent of an acute angle, and will be set to calculate these functions for a few angles by drawing and measurement. He will then be shown where to find the functions tabulated, and his subsequent work for that term will consist largely in the use of instruments, tables and common sense. A considerable choice of problems is available at once. He may solve right-angled triangles, work sums on "heights and distances," plot the graphs of functions of angles, and make some progress in the general solution of triangles by dividing the triangle into right-angled triangles. Only twc trigonometrical identities should be introduced—

$$\sin^2\theta + \cos^2\theta = 1, \text{ and } \frac{\sin\theta}{\cos\theta} = \tan\theta.$$

In short, the work should be arithmetic, and not algebra.

Formal algebra cannot be postponed indefinitely; perhaps now will be the time to return to that neglected science. We might introduce here a revision course of algebra, bringing in literal equations, irrational equations, and simultaneous quadratics illustrated by graphs, partial fractions, and binomial theorem for positive integral index. Side by side with this it ought to be possible to do some easy work in mechanics. Graphical statics may be made very simple; if it is taken up at this stage, it might be well to begin with an experimental verification of the parallelogram of forces, though some teachers prefer to follow the historical order and start from machines and parallel forces. Dynamics is rather more abstract; a first course ought probably to be confined to the dynamics of rectilinear motion.

It is not necessary to discuss any later developments. The plan we have advocated will have the advantage of bringing the pupil at a comparatively early stage within view of the elements of new subjects. Even if this is effected at the sacrifice of some deftness in handing a, b and c, one may hope that the gain in interest will be a motive power of sufficient strength to carry the student over the drudgery at a later stage. Some drudgery is inevitable, if he is ultimately to make any use of mathematics. But it must be borne in mind that this will not be required of the great majority of boys at a public school.

We beg to remain, gentlemen,

Yours faithfully,

G. M. BELL, Winchester.
H. H. CHAMPION, Uppingham.
H. CRABTREE, Charterhouse.
F. W. DOBBS, Eton.
C. GODFREY, Winchester.
H. T. HOLMES, Merchant Taylors' School.
G. H. J. HURST, Eton.
C. H. JONES, Uppingham.
H. H. KEMBLE, Charterhouse.
T KENSINGTON, Winchester.
E. M. LANGLEY, Bedford Modern School.
R. LEVETT, King Edward's School, Birmingham.
J. W. MARSHALL, Charterhouse.
L. MARSHALL, Charterhouse.
C. W. PAYNE, Merchant Taylors' School.
E. A. PRICE, Winchester.
D. S. SHORTO, Rugby.
A. W. SIDDONS, Harrow.
R. C. SLATER, Charterhouse.
H. C. STEEL, Winchester.
C. O. TUCKEY, Charterhouse.
F. J. WHIPPLE, Merchant Taylors' School.

CONFERENCE OF SCIENCE TEACHERS.

ONE of the most important of the many educational conferences which it has become customary to hold during the Christmas vacation is that arranged under the auspices of the Technical Education Board of the London County Council. The custom of inviting teachers of science from all parts of the country to attend meetings in London, to discuss the best methods of imparting instruction in the branches of science taught in schools and colleges, was inaugurated four years ago, and each successive year has seen a substantial increase in the attendance. While in 1899 fewer than a hundred teachers, inspectors and others responded to the invitation of the Technical Education Board, there were present at the meetings held on Thursday and Friday last at the South-Western Polytechnic, Chelsea, upwards of four hundred persons, among whom were representatives of every stage of science teaching.

The vice-chairman of the London Technical Education Board, Mr. T. A. Organ, presided at the first meeting and, in a speech welcoming the teachers present, referred to the neglect of science teaching in this country in the past and contrasted this with the admirable efforts made in Germany since the opening of their first chemical laboratories in 1827. As indicating the amount of leeway we have as a nation to make up, he pointed to the fact that there are nearly 10,000 more or less well-trained chemists employed in German factories, and, as half of them have undergone a complete course of several years' training in the technical high schools, it is not surprising that Germany should be gradually securing markets in which originally British trade was supreme. It is unnecessary to repeat